

Chapter 5

ALTERNATIVES

INTRODUCTION

This chapter presents alternatives for developing the required facilities at Tucson International Airport. The required airfield layout typically dictates the locations and arrangements of land uses at an airport. The unique opportunity exists at Tucson International Airport to consider alternative land use concepts as part of the review of airfield alternatives. As described in Chapter 4, the location of the next parallel runway at the Airport is not dictated by the need to provide adequate separation between parallel runways to allow simultaneous landings in poor weather conditions. This situation is different from that at airports in areas that experience poor weather conditions on a regular basis and/or accommodate a large airline hub. Therefore, decisions regarding airfield development could be made to support recommended land use development.

The development alternatives are described and compared in the following sections.

RUNWAY DEVELOPMENT ALTERNATIVES

It was recommended in the 1987 Master Plan that the next runway constructed at the Airport be parallel to and about 1,400 feet* southwest of existing air carrier Runway 11L-29R—initially constructed to a length of 5,000 feet and then extended to 11,000 feet. This runway is referred to as the close parallel runway. It was also recommended that temporary Runway 11R-29L revert to its original designation as a taxiway. Long-range airfield development in the 1987 Master Plan included a third and potentially fourth parallel runway(s) southeast of the passenger terminal complex. These runways are referred to as the far parallel runways. The close and far parallel runway concepts for the Airport are still considered valid.

It is recommended in this Master Plan Update that the next runway at the Airport be constructed initially to accommodate air carrier aircraft rather than being built initially as a general aviation runway (5,000 feet) and then extended to accommodate air carrier aircraft. Since completion of the 1987 Master Plan, the Authority has acquired a significant amount of the land needed to accommodate the far parallel runways as depicted in the Plan. The additional land needed to accommodate the close parallel runway is still owned by the U.S. government and occupied by Hughes Missile Systems, the acquisition of which represents a significant investment. Therefore, it was decided that the Master Plan Update would include a comparison of the close and far parallel runways to determine whether the

*Measured from centerline to centerline. The recommended separation was later reduced to about 1,150 feet on the basis of revised FAA separation criteria.

recommendation to construct the close parallel runway first was still valid. Exhibit 5-1 depicts the close and far parallel runway alternatives considered for this Master Plan Update. The close and far parallel runway alternatives were compared, as described in the following sections. The phrase "far parallel runway" in the discussions that follow refers to a parallel runway separated by approximately 5,000 feet from existing Runway 11L-29R, as recommended in the 1987 Master Plan.

Alternative Locations for the Far Parallel Runway

The runway end locations for the far parallel runway were initially assumed to be the same as identified in the 1987 Master Plan. Those locations had been selected to minimize the effects of aircraft noise in areas northwest of the far parallel runway. Specifically, the requirement was to prevent noise-sensitive land uses from being exposed to aircraft noise of DNL 65* or higher from operations on the runway. In accordance with this requirement, the identified runway location was well southeast of the passenger terminal complex. This runway location also minimized the amount of land that would need to be acquired north of Los Reales Road.

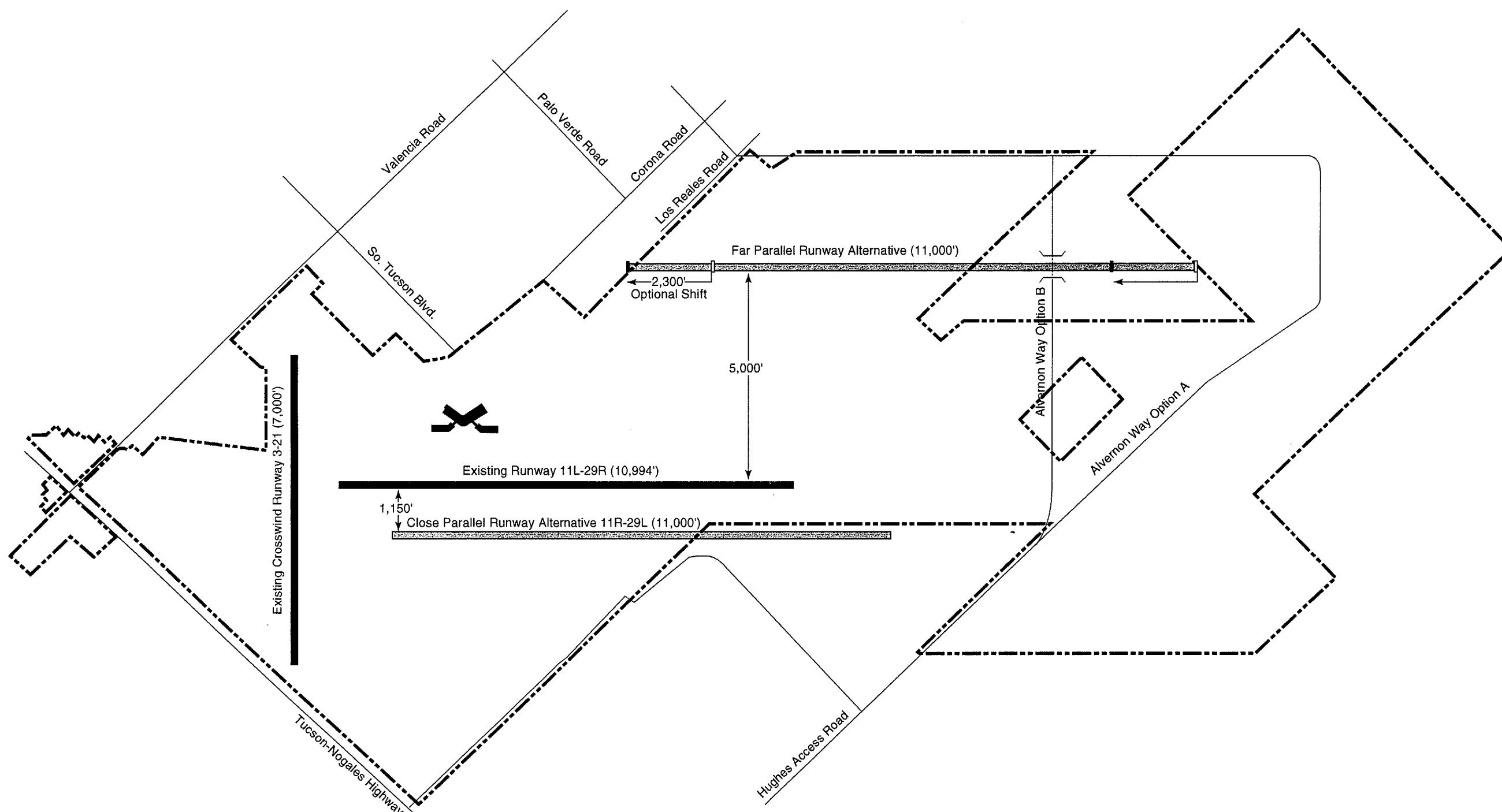
To improve airfield efficiency and to reduce taxiing distances to and from the runways regardless of the direction of air traffic flow (southeast or northwest) by centralizing the passenger terminal between the runway ends, a potential shift of the runway location to the northwest, along its centerline, was considered.

Since completion of the 1987 Master Plan, the U.S. Congress has mandated the phase out of the louder jet aircraft from airline fleets by the year 2000. It was assumed for purposes of this analysis that this phase out would be complete by the time the far parallel runway would be in operation. Therefore, lower aircraft noise levels allowed the potential for pursuing a more northwesterly location of the runway.

The following criteria were used to assess the optimal location of the far parallel runway:

- Average taxiing distance—minimize average aircraft taxiing distances to and from the far parallel runway for departures and arrivals in either direction of operations on the runway
- Aircraft noise exposure—based on the mandated quieter aircraft fleet and existing technology, ensure that no noise-sensitive land uses would be exposed to aircraft noise of DNL 65 and higher

*Annual average day-night sound level (DNL), in decibels. DNL is the standard metric specified by the FAA for describing aircraft noise exposure. In previous Authority planning documents, the abbreviation Ldn has been used to refer to the same measurement.



LEGEND






-  Parallel runway
-  Runway threshold in 1987 Master Plan location
-  Runway threshold for Optional Shift location
-  Existing Airport boundary
-  Tunnel

Exhibit 5-1
PARALLEL RUNWAY ALTERNATIVES
 Master Plan Update
 Tucson International Airport
 November 1996



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- Structure heights—locate the runway so that no existing structures would be obstructions to aircraft operations
- Runway protection zones—locate the runway so that no existing facilities would be within the runway protection zones

From a review of these criteria, it was determined that the most restrictive criterion in terms of the allowable distance for shifting the runway was the runway protection zones. A shift of 2,300 feet northwest from the location depicted in the 1987 Master Plan is the maximum that could be accommodated without requiring the demolition of existing facilities to keep the runway protection zones clear. This shifted location meets all other criteria, and was established as an alternative location for the far parallel runway.

Runway Capacity

As mentioned in Chapter 4, a runway capacity and annual aircraft delay analysis was conducted. During the predominant good weather conditions in Tucson, most aircraft that operate at the Airport could land and take off on existing Runway 11L-29R independently from aircraft landing and taking off on either a close or far parallel runway, with pilots using visual reference to maintain separation from other aircraft. Wake turbulence considerations would affect independent operations on close parallel runways when one of the aircraft is a Boeing 757 or larger aircraft, but these aircraft represent a small percentage of the aircraft currently operating or expected to operate at the Airport. The wake turbulence considerations would not affect operations on the far parallel runways.

In poor weather conditions, pilots use instrument landing system guidance for landing, and may or may not be able to see other aircraft operating at the Airport. Either a new close parallel runway or a new far parallel runway would be equipped with an ILS. However, current FAA requirements specify that two parallel runways must be at least 4,300 feet apart (measured from centerline to centerline) to allow aircraft to land simultaneously on the two runways in poor weather, even if both are equipped with an ILS. (With certain new-technology radar equipment, this requirement is reduced to 3,400 feet.) As stated earlier, the close parallel runway would be about 1,150 feet from Runway 11L-29R. The far parallel runway would be about 5,000 feet from Runway 11L-29R. Therefore, in poor weather, the far parallel runway configuration would offer greater runway capacity than the close parallel runway configuration.

At airports where poor weather conditions occur on a regular basis or that serve large airline hub operations, the difference in capacity could be significant. However, because there is a predominance of good weather* in Tucson and the

*More than 99% of the time based on data provided by the National Oceanographic and Atmospheric Administration.

Airport is not expected to serve a large airline hub, the difference is not considered significant for comparing the benefits of building a close parallel runway or a far parallel runway first.

Aircraft Taxiing Distances

The relative taxiing distances between runways and aircraft parking areas can influence the way runways are used and, to some extent, their effectiveness for accommodating aircraft operations. Taxiing distances from the passenger terminal complex for the close parallel and far parallel runway configurations were compared. As anticipated, assuming the current location of the passenger terminal complex, overall average taxiing distances would be shorter for the close parallel runway than for the far parallel runway. However, if the passenger terminal complex is moved to the southeast as recommended in the 1987 Master Plan, the difference between the average taxiing distances for the two runway configurations decreases. The eventual locations of other land uses at the Airport (e.g., air cargo, corporate aviation, general aviation) would also influence the overall average aircraft taxiing distances to and from the runways.

Order-of-Magnitude Costs

Table 5-1 presents a comparison of the order-of-magnitude costs associated with the close and far parallel runway concept alternatives. The order-of-magnitude costs include land acquisition, environmental considerations, design, administrative tasks, construction of the runway and associated taxiways, and other items.

The estimates show that development of the close parallel runway is less costly than development of the far parallel runway. The primary differences in costs are associated with (1) the realignment of Alvernon Way required for the far parallel runway, (2) the cost of removing land from the 100-year floodplain to accommodate the runway, and (3) the cost of constructing parallel taxiways to the far parallel runway. As noted in the table, the cost for relocating Hughes Missile Systems facilities has been estimated to be about \$25 million. The amount of this relocation cost that will be paid by the Authority is unknown. Even if the Authority were responsible for the total cost, the cost for the close parallel runway would be lower than for the far parallel runway.

LONG-RANGE LAND USE CONCEPT ALTERNATIVES

At most airports, the locations of existing and future airfield facilities most strongly influence land use planning decisions because these facilities occupy the greatest amount of land and the requirements for runway location and orientation are less flexible than for other facilities. However, the opposite is possible at Tucson International Airport—the unique opportunity exists to place more of an emphasis

Table 5-1
ORDER-OF-MAGNITUDE COSTS OF RUNWAY CONCEPT ALTERNATIVES
 Tucson International Airport

Cost item	Close parallel runway	Far parallel runway	
		1987 Master Plan location	2,300 feet northwest
Land acquisition	\$ 8,550,000	\$ 4,430,000	\$ 6,400,000
Environmental documentation	200,000	300,000	300,000
Environmental mitigation	1,500,000	6,500,000 (a)	6,500,000 (a)
Design/construction administration	4,990,000	9,850,000 (b)	9,230,000 (b)
		9,460,000 (c)	9,464,000 (c)
Construction	11,200,000	11,200,000	11,200,000
Lighting and marking	2,700,000	2,700,000	2,700,000
Instrumentation/utilities	1,200,000	1,200,000	1,200,000
Associated taxiway improvements	7,650,000	17,800,000	17,800,000
Alvernon Way realignment	--	10,560,000 (b)	7,440,000 (b)
		8,620,000 (c)	8,620,000 (c)
Relocation of Hughes Missile Systems facilities	n.a. (d)	--	--
Powerline relocation	--	1,800,000	1,800,000
Aircraft rescue and fire fighting facility	--	4,000,000	4,000,000
Total	\$37,990,000 (d)	\$70,340,000 (b)	\$68,570,000 (b)
		\$68,010,000 (c)	\$69,984,000 (c)

n.a. = not available.

- (a) Costs associated with removing land from the 100-year floodplain to accommodate the runway and the required channelization, drainage, and runway elevation.
- (b) Alvernon Way relocated around runway protection zone at the southeast end of the runway—no tunnel required.
- (c) With tunnel for Alvernon Way under new runway. Tunnel option requires relocation or closure of Swan Road—not included in cost estimates.
- (d) The estimated costs for relocating Hughes Missile Systems facilities is \$25 million. The costs that would be paid by the Tucson Airport Authority are unknown at this time.

Source: Urban Engineering, Inc., July 1996.

on land use planning decisions that may eventually influence decisions regarding the location and phasing of future airfield facilities. After a review of the airfield requirements and the comparison of the close and far parallel runway concepts described above, Authority staff decided to consider land use planning concepts before developing final runway locations and phasing plans for future airfield development. As anticipated, the overall concept for the ultimate airfield has not changed significantly from that in the 1987 Master Plan. However, the phasing plan for moving toward that ultimate airfield could be dependent on how land uses develop on the Airport in addition to the considerations described above.

Each planning concept included all land uses, in addition to the airfield, that would occupy the largest land areas at the Airport. Other Airport land uses are also included in the recommended plan, but were not considered critical for comparing the concept components. The critical land uses identified in the planning concepts include:

- ***Airfield:*** Runways, taxiways, runway protection zones, building restriction lines, and airfield approach zones.
- ***Passenger terminal complex:*** Passenger terminal building, aircraft parking apron, automobile parking (public, rental, employee), terminal roadways, and associated uses.
- ***General/corporate aviation:*** Fixed base operator facilities and other activities that involve the sale of general aviation products and services to the public and facilities for basing and servicing private aircraft maintained by individuals or organizations. Facilities include terminal areas where passengers on visiting business and corporate aircraft can access ground transportation, rental cars, and U.S. Customs and other inspection services.
- ***Terminal support:*** Facilities that provide a wide range of support services for the Airport terminal, such as long-term parking, Airport administration, concessions services, the FAA, and other federal services such as U.S. Customs and the National Weather Service.
- ***Airline support/belly cargo/maintenance:*** Facilities that provide services to the airlines, such as inflight catering, fuel farms, belly cargo, and maintenance. Belly cargo includes U.S. mail, parcels from freight forwarders, and express or other cargo parcels brought to the Airport by individuals or businesses to be carried on passenger rather than all-cargo aircraft.
- ***Air cargo:*** Facilities related to enplaned and deplaned cargo shipped on all-cargo aircraft. This includes the overnight parcel air service providers (e.g., FedEx, Airborne Express), as well as other bulk cargo carriers (e.g., Emery Worldwide, Evergreen International).

- **Industrial/cargo:** Aviation- and nonaviation-related commercial and industrial uses that may include offices, warehouses, and manufacturing plants. These facilities would have potential access to the airfield, rail lines, and highways and would be intended to accommodate multimodal transportation needs and potential trade between the United States and Mexico.

Five preliminary land use and illustrative development concepts were prepared and discussed with Tucson Airport Authority staff. At the conclusion of that discussion, three concepts that included certain unique elements from each of the five preliminary versions were developed for further consideration. The concepts *did not* represent individual alternative land use plans for the Airport. The illustrative drawings were intended to depict how various elements *could* be developed and were not used to directly compare overall concepts nor the actual design or configuration of structures and areas.

It was anticipated that the recommended land use plan would include elements from one or more of the concepts illustrated to reflect input from the Long-Range Planning Council and the Technical Advisory Committee and technical comparisons.

Certain elements are consistent in all three concepts:

- The ultimate airfield includes three parallel air carrier runways and the existing crosswind runway to illustrate the relationships between alternative land uses and the airfield. The locations of the future runways are as shown on the current Airport Layout Plan. A fourth parallel general aviation runway is depicted on Concept B, consistent with the 1987 Master Plan.
- The area southwest of the main parallel runways includes the existing Learjet facility, along with a combined industrial/cargo use. The Learjet facility is considered to be general/corporate aviation and is in an area that is under a long-term lease. The industrial/cargo area is located to facilitate access to existing rail and highway facilities.
- Primary access to the passenger terminal complex would continue to be via South Tucson Boulevard, although internal circulation may vary.
- The international facilities are assumed to be included in the passenger terminal complex in the long term.

The components of each of the three overall concepts are described below, along with graphic depictions.

Concept A

Concept A is depicted on Exhibits 5-2 and 5-3 and consists of the following components:

- An ultimate airfield consisting of three parallel air carrier runways and the crosswind runway.
- Passenger terminal complex expansion to the southeast to be developed as needed.
- Corporate and general aviation facilities northwest of the passenger terminal complex, around the Learjet site, and on the southern portions of the west ramp area.
- Airport and terminal support functions east of the passenger terminal complex.
- Airline support/belly cargo/maintenance facilities southeast of the passenger terminal complex. Development of the far parallel runway to the southeast would ultimately result in the need for a tunnel under the taxiways or around the southeast ends of the runways to access this area.
- Air cargo facilities east/southeast of the passenger terminal complex in an area identified as "reserve for general aviation" in the 1987 Master Plan.

Concept B

Concept B is depicted on Exhibits 5-4 and 5-5 and consists of the following components:

- An ultimate airfield consisting of three parallel air carrier runways and the crosswind runway, and a fourth parallel runway farther east to accommodate general aviation operations.
- Passenger terminal complex expansion both to the southeast and to the northwest that would be developed as needed.
- Corporate and general aviation facilities around the Learjet site and in the southeast location consistent with recommendations in the 1987 Master Plan.
- Airport and terminal support functions east of the passenger terminal complex.
- Airline support/belly cargo/maintenance facilities southeast of and adjacent to the passenger terminal complex.

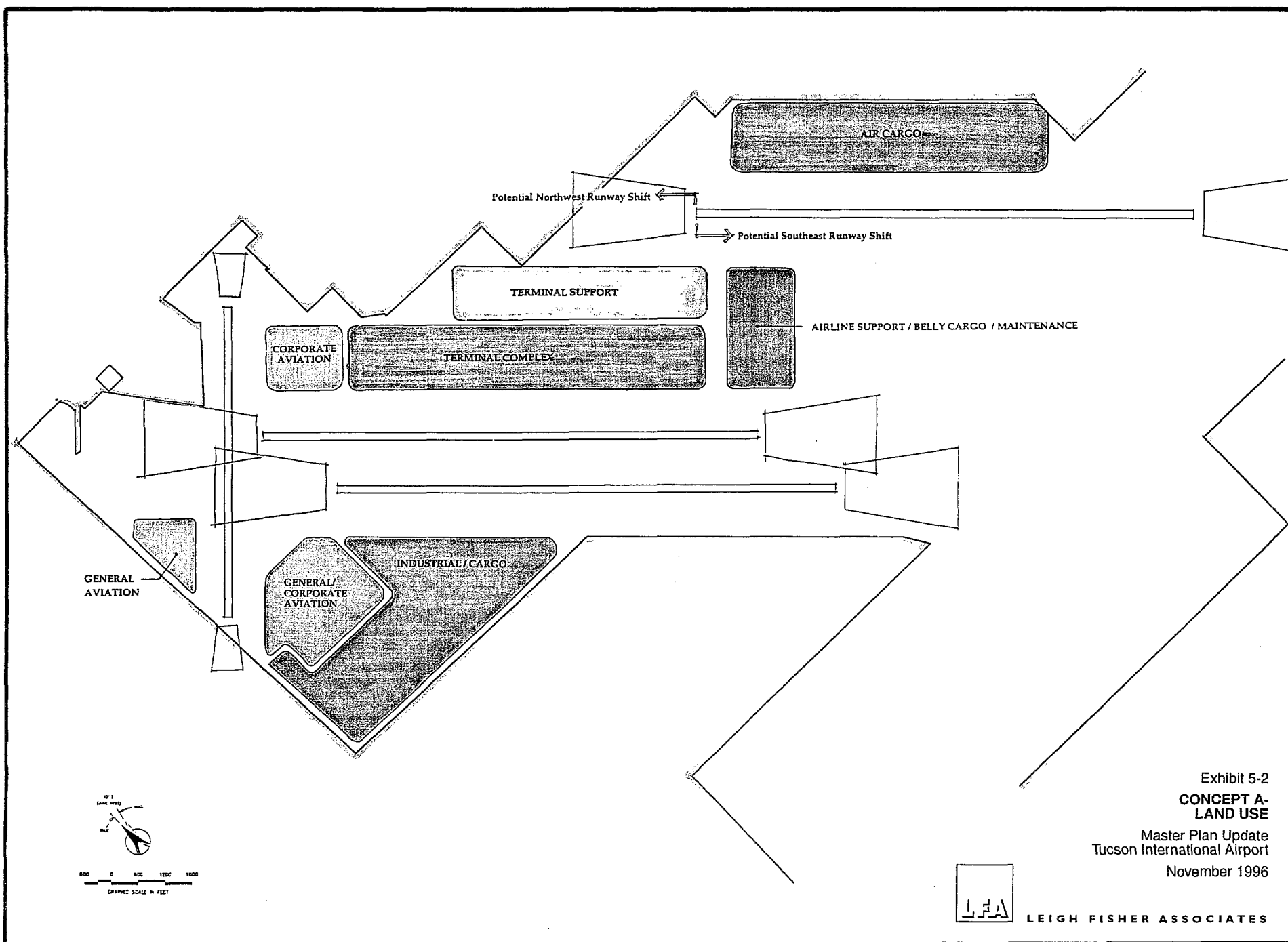


Exhibit 5-2
**CONCEPT A-
 LAND USE**

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 Tucson International Airport
 November 1996



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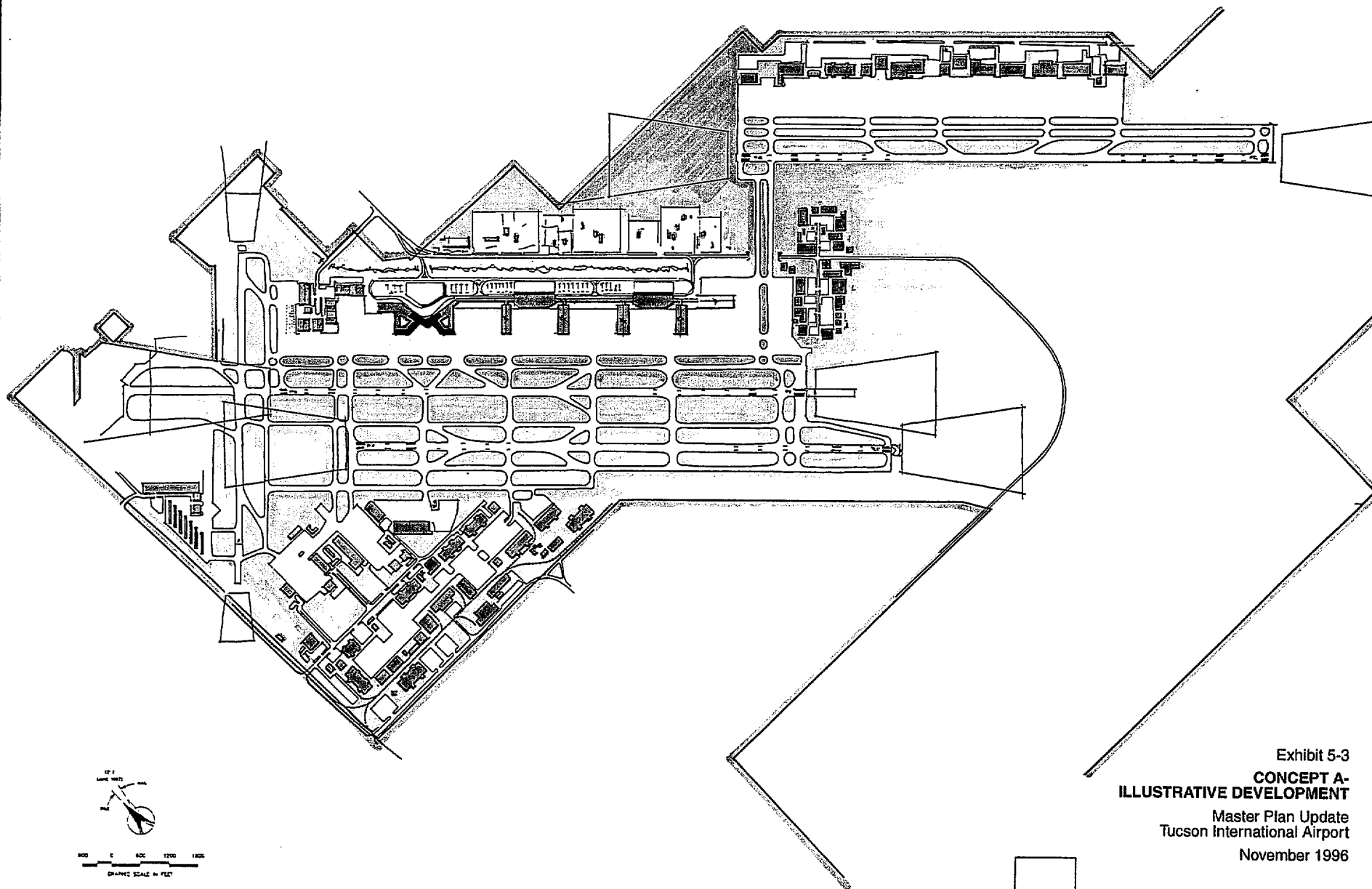
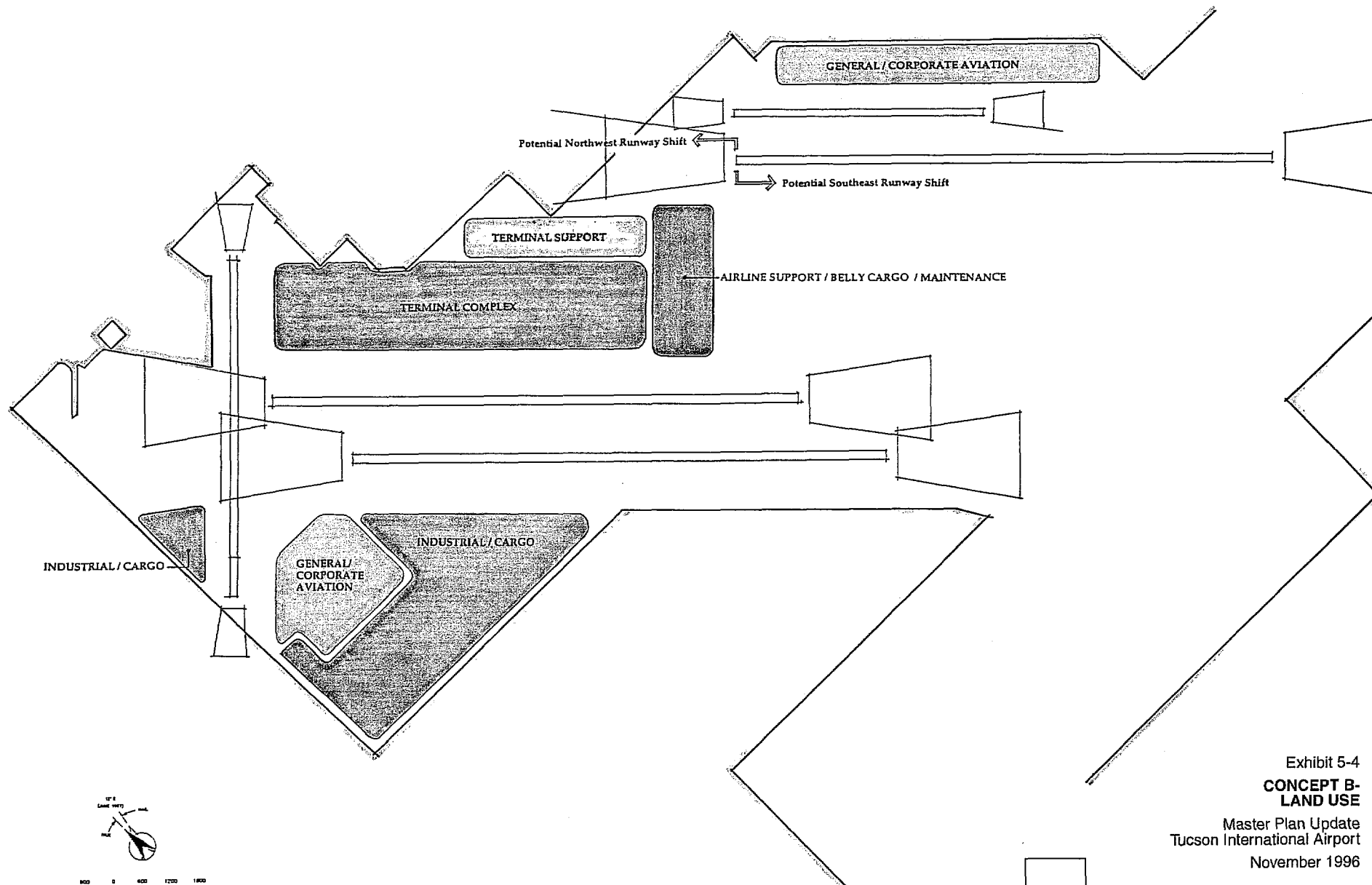


Exhibit 5-3
**CONCEPT A-
ILLUSTRATIVE DEVELOPMENT**

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November 1996



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GRAPHIC SCALE IN FEET

Exhibit 5-4
**CONCEPT B-
 LAND USE**
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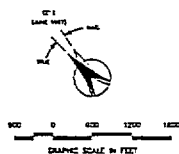
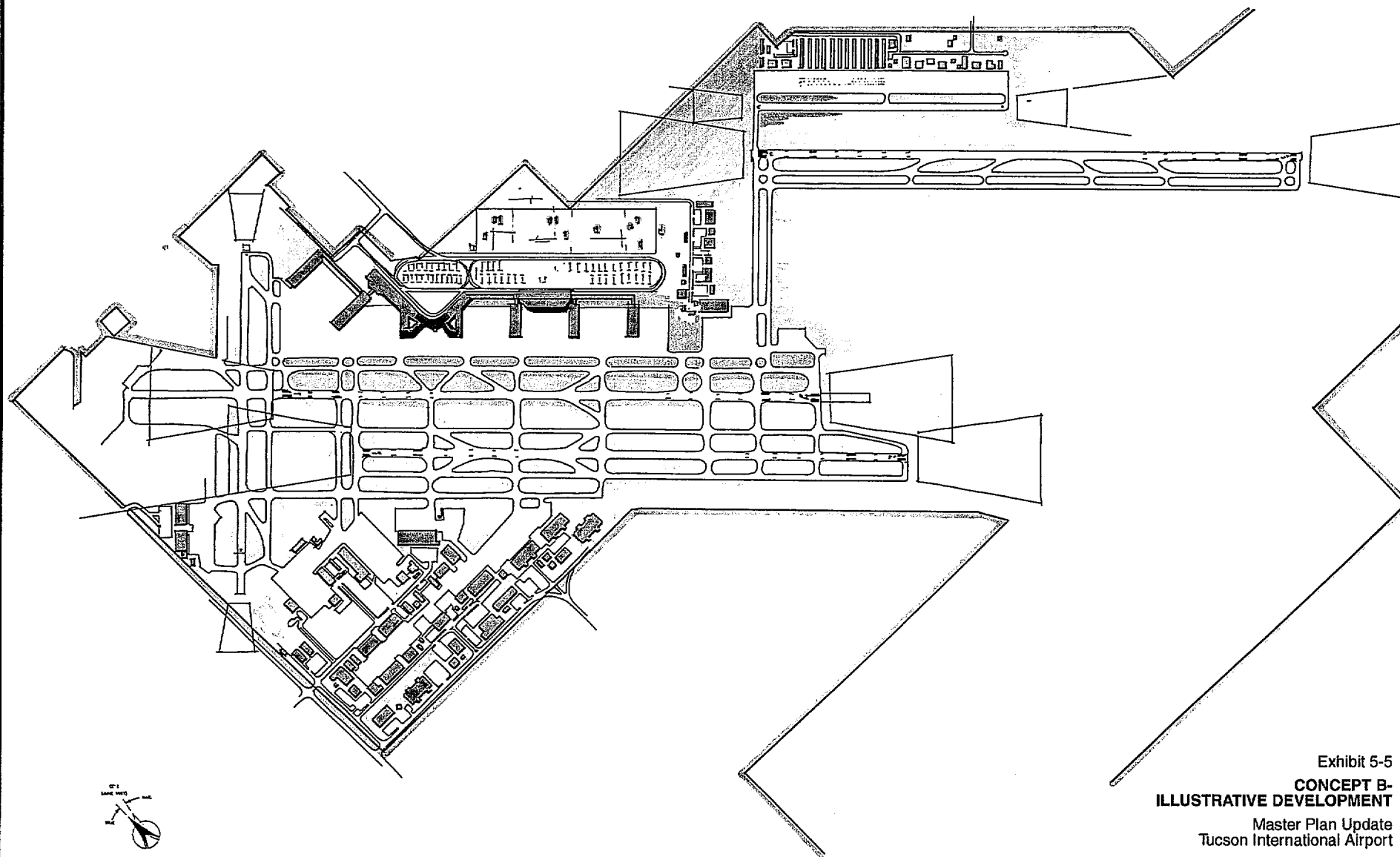


Exhibit 5-5
**CONCEPT B-
ILLUSTRATIVE DEVELOPMENT**
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Tucson International Airport
November 1996



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- Air cargo in the southwest industrial/cargo area and in the southern portion of the west ramp area. Additional air cargo areas, if needed, could be developed southeast of the passenger terminal complex and airline support area.

Concept C

Concept C is depicted on Exhibits 5-6 and 5-7 and consists of the following components:

- An ultimate airfield consisting of three parallel air carrier runways and the crosswind runway.
- Passenger terminal complex relocation to the southeast, with eventual abandonment of the existing passenger terminal complex area for such use.
- Corporate and general aviation facilities in an expanded area northwest of the passenger terminal complex and in the area around the Learjet site.
- Airport and terminal support functions northwest of the passenger terminal complex.
- Airline support/belly cargo/maintenance facilities northwest of the passenger terminal complex. Development of the far parallel runway to the southeast would ultimately result in the need for a tunnel under the taxiways or around the southeast end of the runways to access this area.
- Air cargo facilities in the southwest industrial/cargo area and in the southern portion of the west ramp area. Additional air cargo areas, if needed, could be developed southeast of the passenger terminal complex and airline support area.

PLANNING GUIDELINES AND COMPARISONS OF LAND USE CONCEPTS AND RUNWAY ALTERNATIVES

Planning guidelines for the Master Plan Update were established as an early task in the project and are described in Chapter 1 of this document.

Each of the three land use and illustrative development concepts includes the components required to meet these planning guidelines, although some of the guidelines are met in different ways among the concepts.

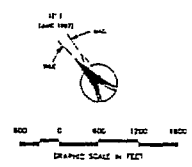
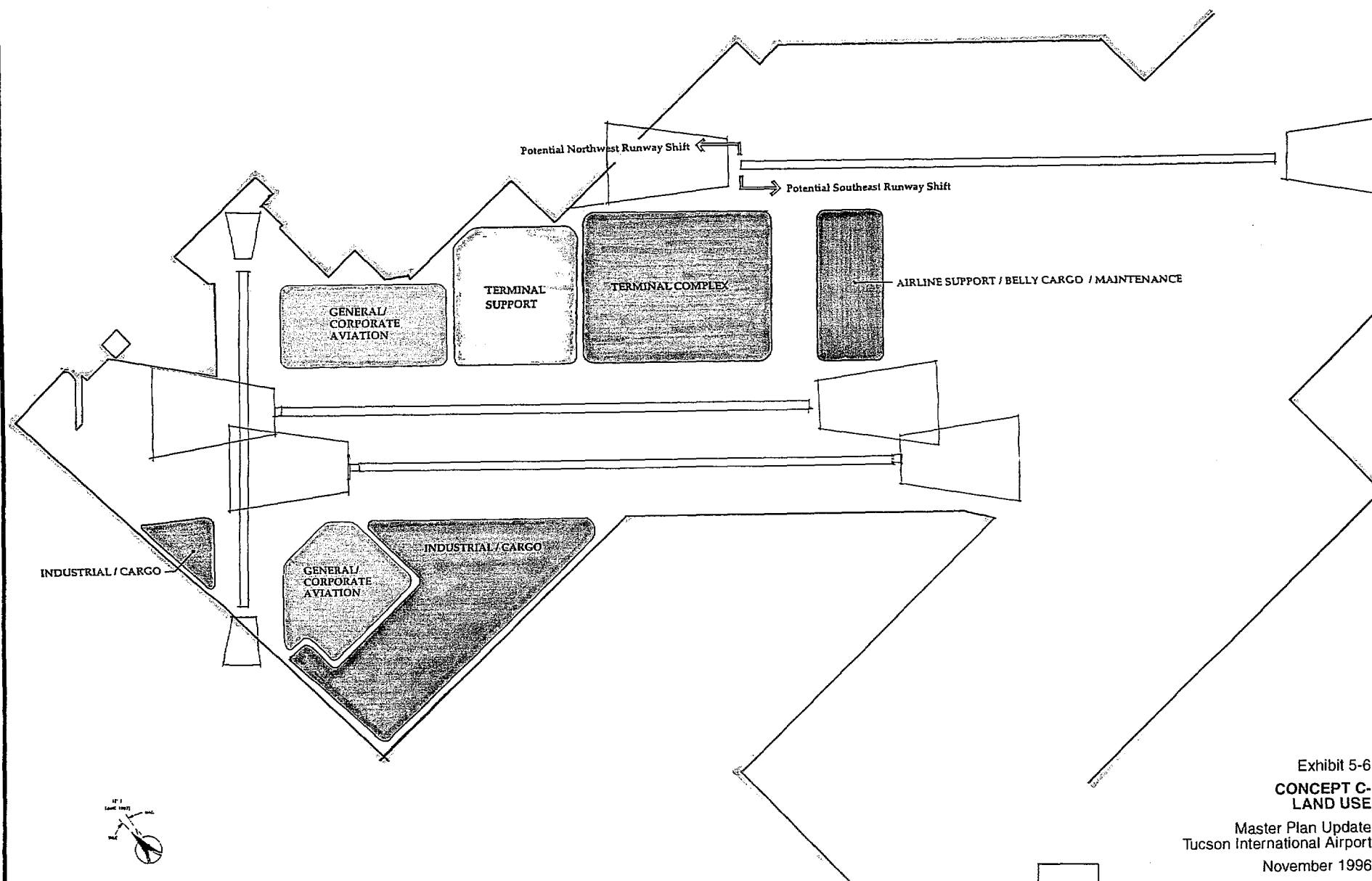


Exhibit 5-6
**CONCEPT C-
LAND USE**
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Tucson International Airport
November 1996

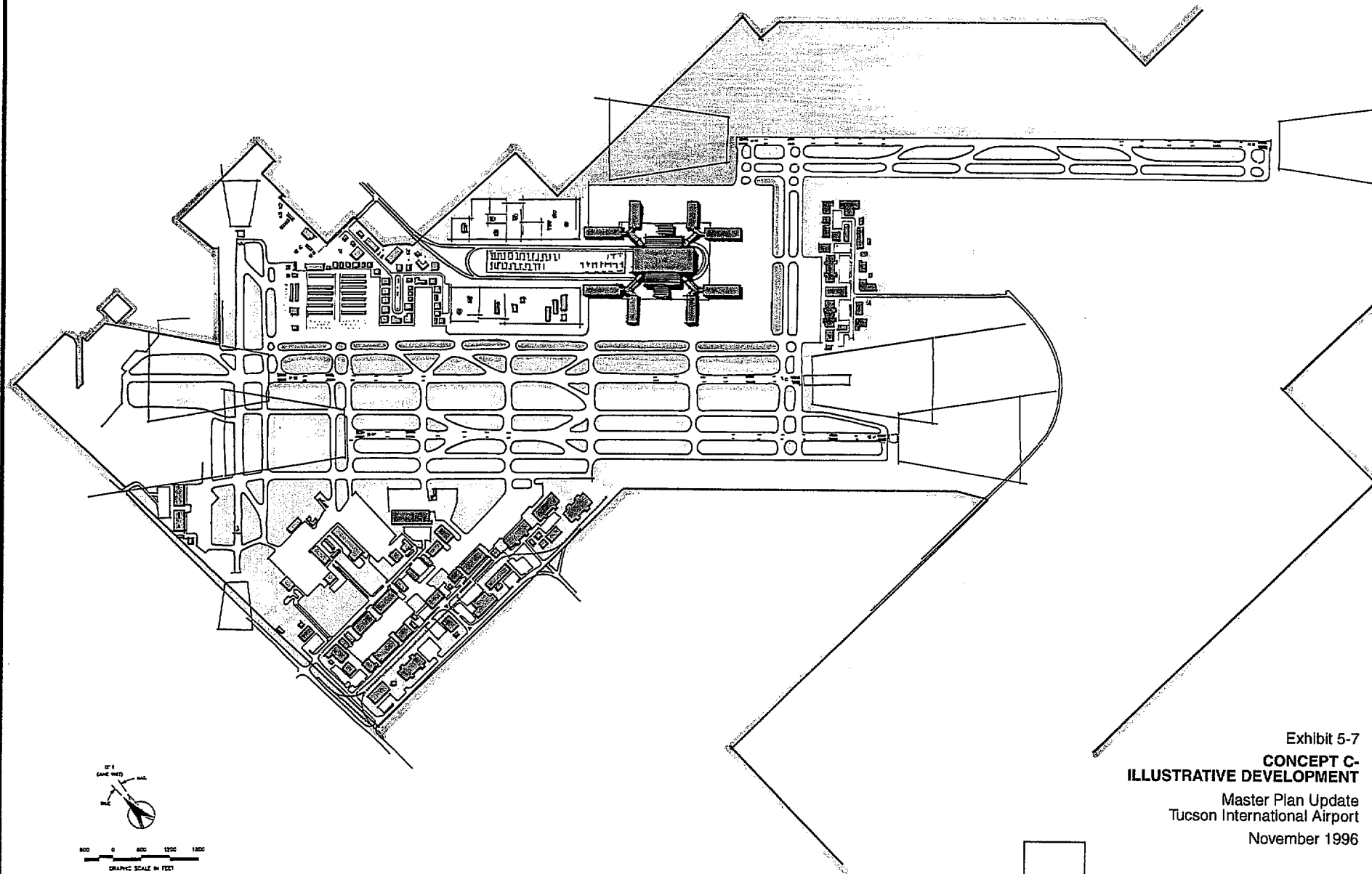


Exhibit 5-7
**CONCEPT C-
ILLUSTRATIVE DEVELOPMENT**

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Tucson International Airport
November 1996



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The merits of the land use concepts and the parallel runway alternatives were compared for the Master Plan Update. The comparative criteria were based on the planning guidelines. Tables 5-2 and 5-3 present comparisons of the land use concepts and the parallel runway development alternatives, respectively, that were used to establish the recommended Master and Land Use Plan for Tucson International Airport.

Table 5-2
COMPARISON OF LONG-RANGE LAND USE CONCEPT ALTERNATIVES
Tucson International Airport

Criterion	Concept A	Concept B	Concept C
Ability to accommodate future demand for aircraft, passengers, and vehicles	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion
Project costs (terminal concepts)	<ul style="list-style-type: none"> \$125 million 	<ul style="list-style-type: none"> \$125 million 	<ul style="list-style-type: none"> \$170 million
Environmental effects	<ul style="list-style-type: none"> Potential environmental remediation in area near existing AANG test pad Eventual effects on drainage channel southeast of existing cargo area Terminal and parking expansion could require air quality conformity determination 	<ul style="list-style-type: none"> Potential environmental remediation in area near existing AANG test pad Eventual effects on drainage channel southeast of existing cargo area Terminal and parking expansion could require air quality conformity determination 	<ul style="list-style-type: none"> Potential environmental remediation in area near existing AANG test pad Effects on drainage channel southeast of existing cargo area from terminal construction Construction of new terminal could require detailed air quality review and conformity determination.
Ability to meet long-range goals	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion
Phasing considerations	<ul style="list-style-type: none"> Allows incremental terminal expansion Cargo facilities would need to be relocated for ultimate terminal expansion—not likely within planning period Temporary changes to ground access and parking may be necessary during construction of new terminal Requires eventual reconstruction of existing terminal building 	<ul style="list-style-type: none"> Allows incremental terminal expansion Ground access and parking effects likely during construction of new terminal Requires eventual reconstruction of existing terminal building 	<ul style="list-style-type: none"> Construction of new terminal would begin when existing terminal and concourses reach capacity Operations at existing terminal would be largely unaffected during new construction Corporate/general aviation could expand after demolition of existing terminal building New air cargo facility development could be preserved
Other considerations	<ul style="list-style-type: none"> Ultimate passenger terminal development would require eventual relocation of air cargo facilities. Maintains general aviation near Runway 3-21—short taxi distance for crosswind runway use Cargo development to the southeast in area previously reserved for general aviation would be associated with far parallel runway construction General aviation runway to the southeast shown on existing master plan not needed 	<ul style="list-style-type: none"> Ultimate passenger terminal moved toward constrained area northwest of existing facility and requires relocation of general aviation facilities General aviation moved away from Runway 3-21—long taxiing distance for crosswind runway use 	<ul style="list-style-type: none"> Allows eventual expansion of corporate/general aviation in its present, constrained location northwest of the existing terminal Could alleviate taxiing problems near the intersection of Runways 11L-29R and 3-21 Centralizes terminal area to the far parallel runway configuration General aviation runway to the southeast shown on existing master plan not needed

Note: Project costs are order-of-magnitude for terminal facilities to accommodate traffic through PAL 4 (see Table 4-1) and are to be used for comparison purposes only.

Source: Leigh Fisher Associates, August 1996.

Table 5-3
COMPARISON OF PARALLEL RUNWAY DEVELOPMENT ALTERNATIVES
Tucson International Airport

Criterion	Close parallel runway	Far parallel runway
Ability to accommodate future demand for aircraft, passengers, and vehicles	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion
Project costs	<ul style="list-style-type: none"> \$38.0 million (includes associated taxiway improvements and land acquisition, relocation of Hughes Missile Systems facilities not included—see Table 5-1) 	<ul style="list-style-type: none"> \$68.0 million to \$70.3 million—air carrier runway in location shown on existing master plan (includes new taxiway access and land acquisition) \$68.6 million to \$70.0 million additional if the runway is shifted 2,300 feet to the northwest \$3.7 million additional for parallel general aviation runway (Concept B only)
Environmental effects	<ul style="list-style-type: none"> No significant increases in noise levels anticipated over noise-sensitive land uses Relocation of Hughes facilities and associated environmental cleanup required No significant environmental effects identified with respect to the runway in the environmental assessment for land acquisition—an environmental assessment (and possibly an environmental impact statement) specifically addressing runway development would be required 	<ul style="list-style-type: none"> Original location of runway established to prevent significant increases in noise over noise-sensitive land uses; shift to northwest would be toward primarily compatible development; some hotels and businesses could be exposed to significant aircraft noise Shift to northwest would require relocation of Los Reales Road and associated environmental effects Potential air quality concerns associated with longer taxiing distance with Terminal Concepts A and B Runway is in the 100-year floodplain associated with Airport Wash A full environmental assessment (and possibly an environmental impact statement) would be required
Ability to meet long-range goals	<ul style="list-style-type: none"> Meets criterion 	<ul style="list-style-type: none"> Meets criterion
Phasing considerations	<ul style="list-style-type: none"> Requires intermittent closure of temporary Runway 11R-29L during part if not all of runway construction period Requires acquisition of land and relocation of Hughes facilities Portions of the west ramp would need to be cleared prior to runway opening 	<ul style="list-style-type: none"> Requires realignment of and/or construction of a tunnel for Alvernon Way May require relocation or closure of Swan Road Requires relocation of power lines along Swan Road Land acquisition required prior to runway construction
Other considerations	<ul style="list-style-type: none"> Shorter overall average taxiing time for passenger aircraft than for far parallel runway with Terminal Concepts A and B Taxiing time nearly equal for two runway concepts with Terminal Concept C 	<ul style="list-style-type: none"> Parallel runway separation would allow independent (simultaneous) landings in instrument weather conditions, which occur less than 1% of the year Longer average taxiing time than for close parallel runway for Terminal Concepts A and B (difference as much as 1.5 minutes per operation) Taxiing time nearly equal for two runway concepts with Terminal Concept C

Note: Project costs are order-of-magnitude and are to be used for comparison purposes only.

Source: Leigh Fisher Associates, August 1996.